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STUDY OF HELMET MOUNTED SIGHT/DISPLAY INTERFACE CONCEPTS FOR F---ETC(U)
JUN 77 F33657-77-M-0219

UNCLASSIFIED NL

1 OF 1
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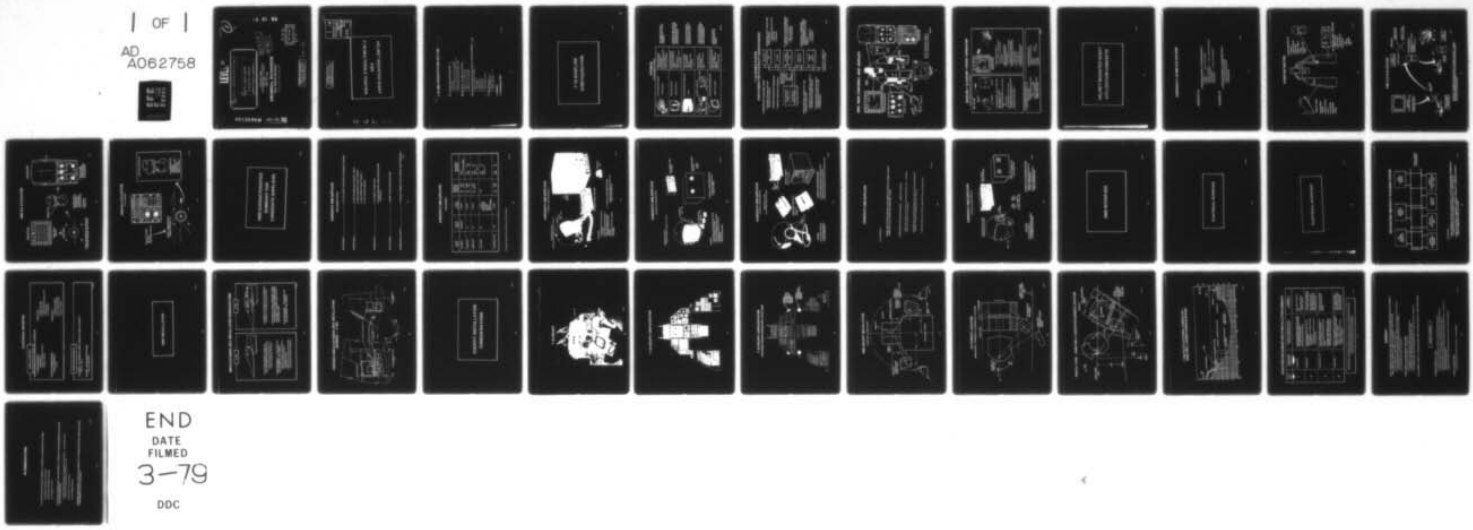

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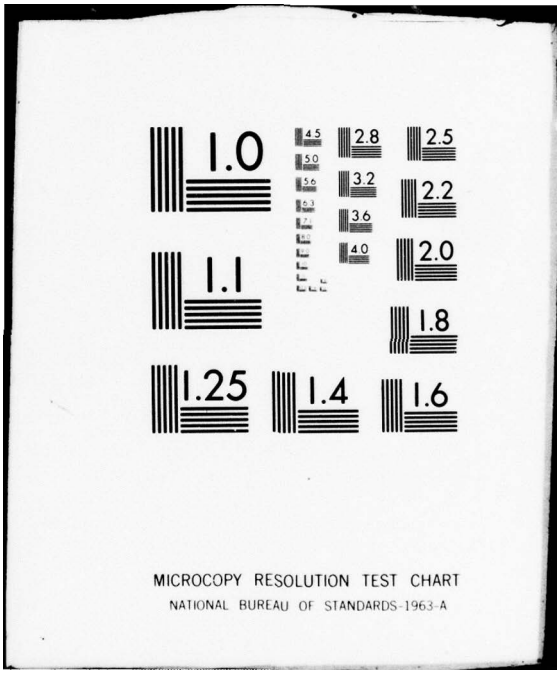
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

LEVEL II

1 June 1977

(1)

SC

(9) FINAL PRESENTATION

(6) STUDY OF HELMET MOUNTED SIGHT/DISPLAY INTERFACE CONCEPTS FOR F-16 AIRCRAFT

402 709

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Fort Worth Division
P. O. Box 748, Fort Worth, Texas 76101

78 12 21 146

402 709

slt

HELMET MOUNTED SIGHT
FOR
F-16 MULTIROLE FIGHTER

F-16 HMS PRESENTATION OUTLINE

- F-16 BASELINE CONFIGURATION;
  - *AVIONICS*
  - *PARTITIONED SYSTEM CONCEPT*
  - *ONE MAN CONTROLS AND DISPLAYS*
  - *BASELINE SYSTEM CAPABILITIES*
- CANDIDATE F-16 HMS UTILIZATION;
  - *HMS A/A UTILIZATION*
  - *HMS A/G UTILIZATION*
  - *HMS NAV UTILIZATION*
- CANDIDATE SUPPLIER HMS CHARACTERISTICS SUMMARY; and
  - *DEVELOPMENT STATUS*
  - *POLHEMUS*
  - *HONEYWELL*
  - *MAGNAVOX*
  - *RAYTHEON*
  - *MARCONI-ELLIOTT*
- HMS INTERFACE.
  - *ELECTRICAL*
  - *INSTALLATION*
- SUMMARY
- RECOMMENDATIONS

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F-16 BASELINE CONFIGURATION

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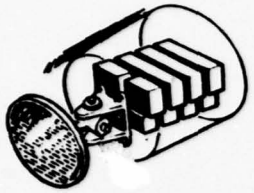
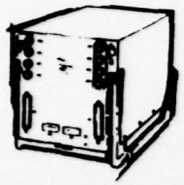
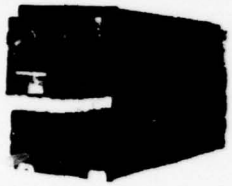
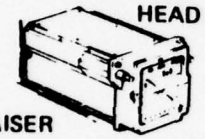
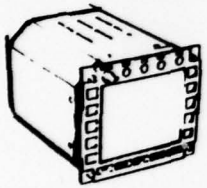
AVIONICS

● FIRE CONTROL SYSTEM

	● FIRE CONTROL RADAR WESTINGHOUSE	● DOPPLER-SHARPENED GROUND MAP MODE ● BEACON MODE ● AIR-TO-GROUND RANGING ● FREEZE CAPABILITY ● ANTI-SHIP SEA MODES
	● NAVIGATION SET SINGER-KEARFOTT	● AUTONOMOUS INERTIAL ● NORMAL GYROCOMPASS AND QUICK REACTION MODES ● HIGH ACCURACY – BETTER THAN 1 N. Mi/HR AND 3 FPS/AXIS
	● FIRE CONTROL COMPUTER DELCO	● GENERAL PURPOSE DIGITAL COMPUTER WITH 32,000 WORD MEMORY ● 274,000 OPERATIONS PER SECOND
 	● COCKPIT DISPLAYS	● HEADUP GUNNERY & MISSILE SOLUTIONS ● HEAD DOWN TV MONTIOR FOR RADAR & E-O
	● STORES MANAGEMENT SET GENERAL DYNAMICS	● MICROPROCESSOR CONTROL ● NON-VOLATILE LOAD AND PROFILE MEMORY ● READ ONLY PROGRAM MEMORY ● FULLY REDUNDANT

MULTIMODE RADAR WITH ADVANCED DIGITAL SIGNAL PROCESSING

UNLIMITED GLOBAL INERTIAL NAVIGATION. VISUAL, RADAR AND TACAN UPDATES. BACK UP BUS CONTROLLER

SOFTWARE PROGRAMMABLE. CONTINUOUS SOLUTIONS FOR UNCONSTRAINED ATTACK

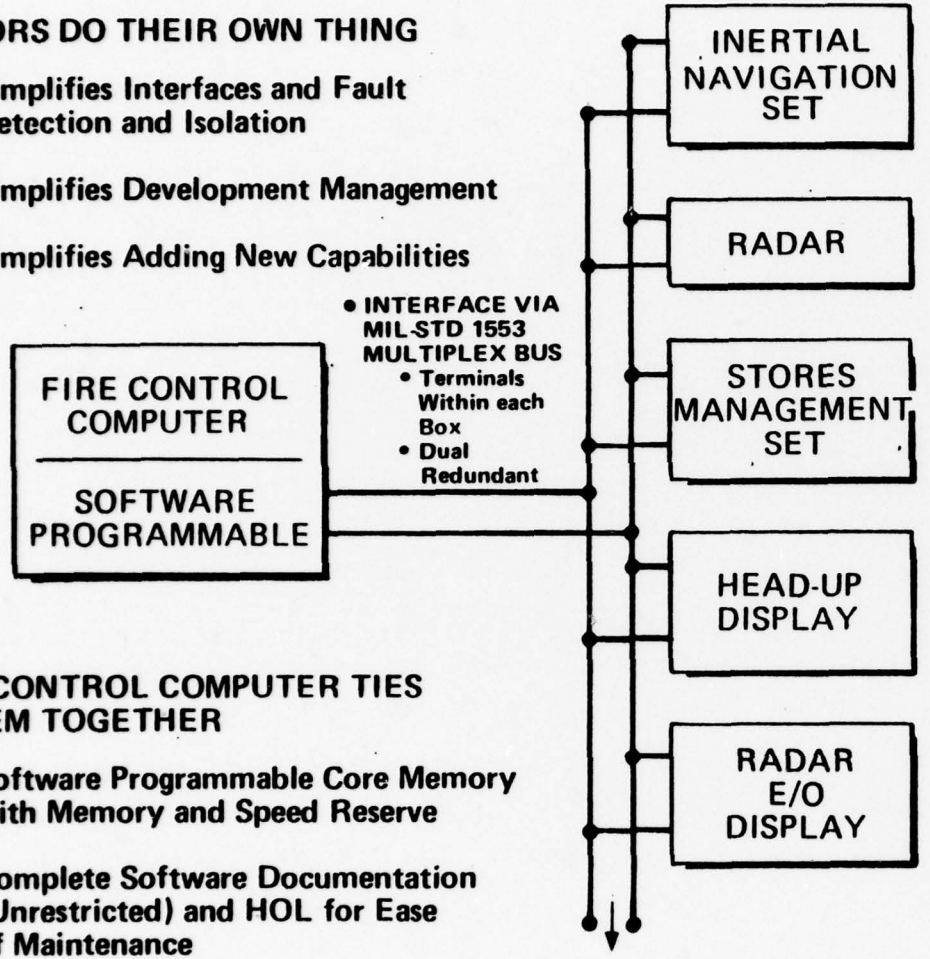
TARGET IDENTIFICATION & ACQUISITION, WEAPON AIMING, FLIGHT REFERENCE CUES & ENERGY MANAGEMENT

CONTROLS AVIONICS DELIVERY MODE AND WEAPONS

6B9436A

F-16 AVIONIC SYSTEM
PARTITIONED FOR FLEXIBILITY & MAINTENANCE

- SENSORS DO THEIR OWN THING
  - Simplifies Interfaces and Fault Detection and Isolation
  - Simplifies Development Management
  - Simplifies Adding New Capabilities



- FIRE CONTROL COMPUTER TIES SYSTEM TOGETHER
  - Software Programmable Core Memory with Memory and Speed Reserve
  - Complete Software Documentation (Unrestricted) and HOL for Ease of Maintenance

- SENSORS HAVE THEIR OWN PROCESSORS
  - A Supplier Does His Total Sensor Job
  - Flexibility

- FIRMWARE PROGRAMMABLE CENTRAL INTERFACE UNIT
  - Memory Reserve
  - Fully Redundant

- SEPARATE 'FIRMWARE' PROGRAMMABLE SYMBOL GENERATORS FOR EACH DISPLAY
  - Involatile but . . . .
  - Changeable

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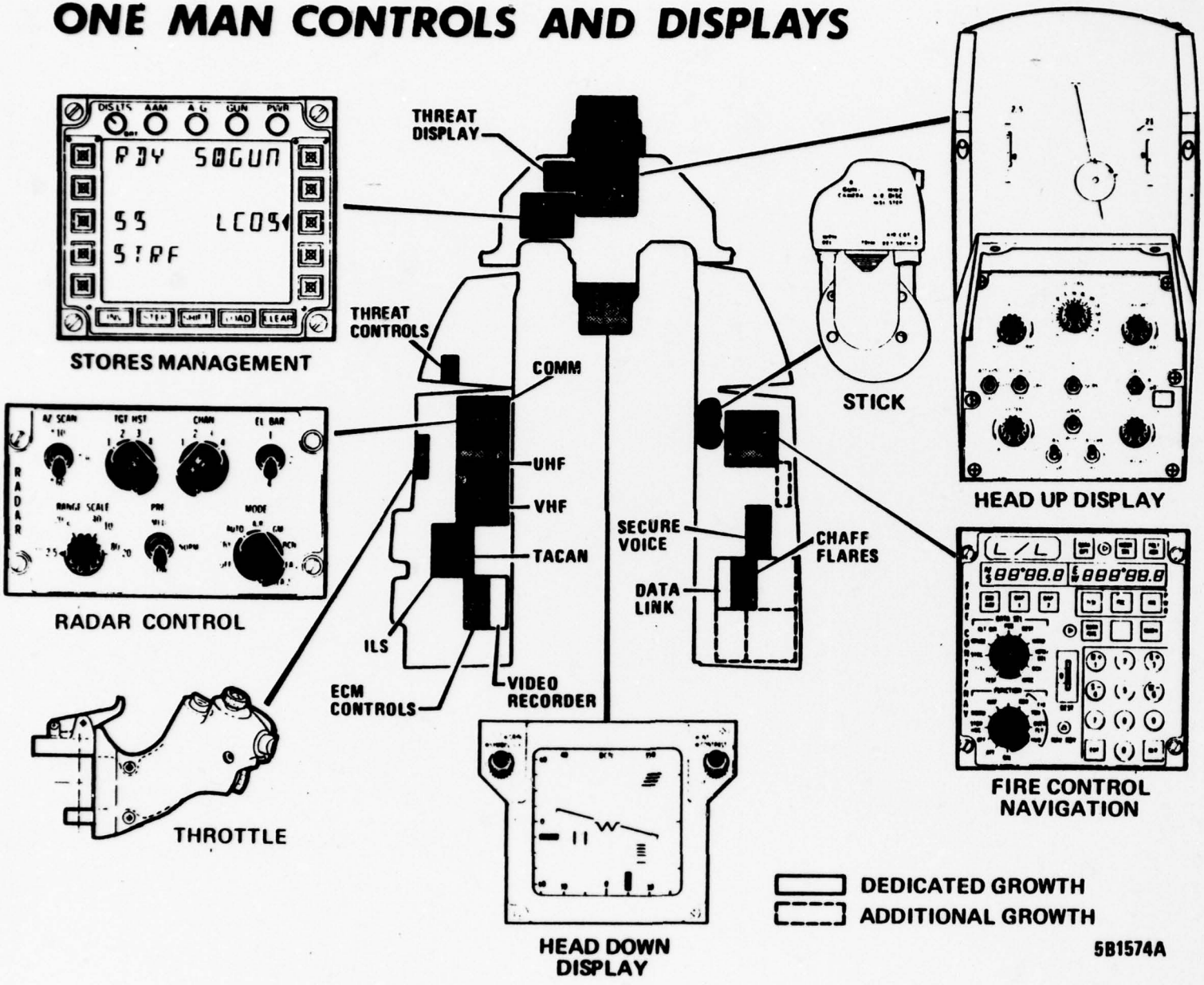
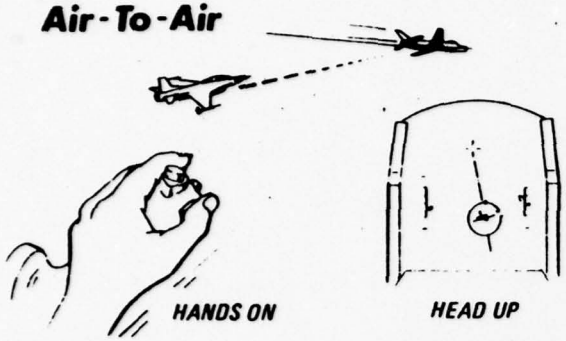
ONE MAN CONTROLS AND DISPLAYS



BASELINE F-16 AVIONIC SYSTEM CAPABILITIES

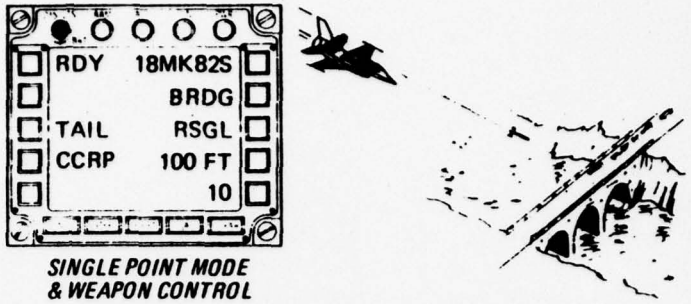
- F-16 ALL WEATHER, DUAL ROLE CAPABILITY

Air-To-Air



- ALL WEATHER SEARCH, ANGLE & RANGE TRACK
- LOOK-DOWN DETECT, ACQUIRE, AND TRACK IN CLUTTER
- AUTOMATIC RADAR ACQUISITION FOR DOGFIGHT
  - Gun
  - AIM-9 J/L Missiles
- SINGLE SWITCH ENTRY INTO AIR-TO-AIR
- INTEGRATED DISPLAY OF ENERGY MANAGEMENT CUES AND FLIGHT REFERENCE DATA
- PROVISIONS FOR RADAR MISSILE

Air-To-Surface



SINGLE POINT MODE & WEAPON CONTROL

- EXTENSIVE WEAPON CAPABILITY
  - Gun • Rockets • Conventional Bombs
  - E/O Weapons • Laser Guided Bombs
  - Nuclear Weapons
- VISUAL DELIVERY AUTOMATICALLY COMPUTED FOR UNCONSTRAINED ATTACK CONDITIONS
  - Level and Dive CCIP and Dive Toss Solutions
- BLIND WEAPON DELIVERY USING RADAR GROUNDMAP OR RADAR BEACON SIGHTING
  - Level and Toss Solutions
- E/O WEAPON DELIVERY
  - Maverick/HOBO (TV)
- TISL PROVISIONS – IDENTIFICATION OF LASER DESIGNATED TARGET

OPERATIONS & SURVIVABILITY

PENETRATION AIDS

- PASSIVE THREAT RADAR WARNING
  - SAM • AI • AAA
- CHAFF/FLARE DISPENSERS
- MODULAR ECM PODS FOR VARIOUS TERMINAL THREAT MIXES

NAVIGATION/COMMUNICATIONS

- INERTIAL PLATFORM (With Rapid Alignment)
- TACAN/ILS
- A/G IFF
- UHF RADIO
- VHF RADIO
- INTERCOM

6B7361

HELMET MOUNTED SIGHT UTILIZATION CONCEPTS

B5075

CANDIDATE F-16 HMS UTILIZATIONS

- **BASELINE F-16**

  ✔ **HMS COULD PROVIDE A LOS DESIGNATION TO:**
  - *RADAR*, *AIM9L* — *AIR TO AIR MODES*
  - *SURFACE TARGET*, *OFFSET AIMPOINT* — *AIR TO SURFACE MODES*
  - *STEERPOINT*, *MARKPOINT* — *NAVIGATION MODES*

- **FUTURE F-16**

  ✔ **HMS COULD PROVIDE A LOS DESIGNATION TO:**
  - *SLAVEABLE E/O WEAPONS*
  - *LASER DESIGNATOR POD*
  - *NEW WEAPONS*

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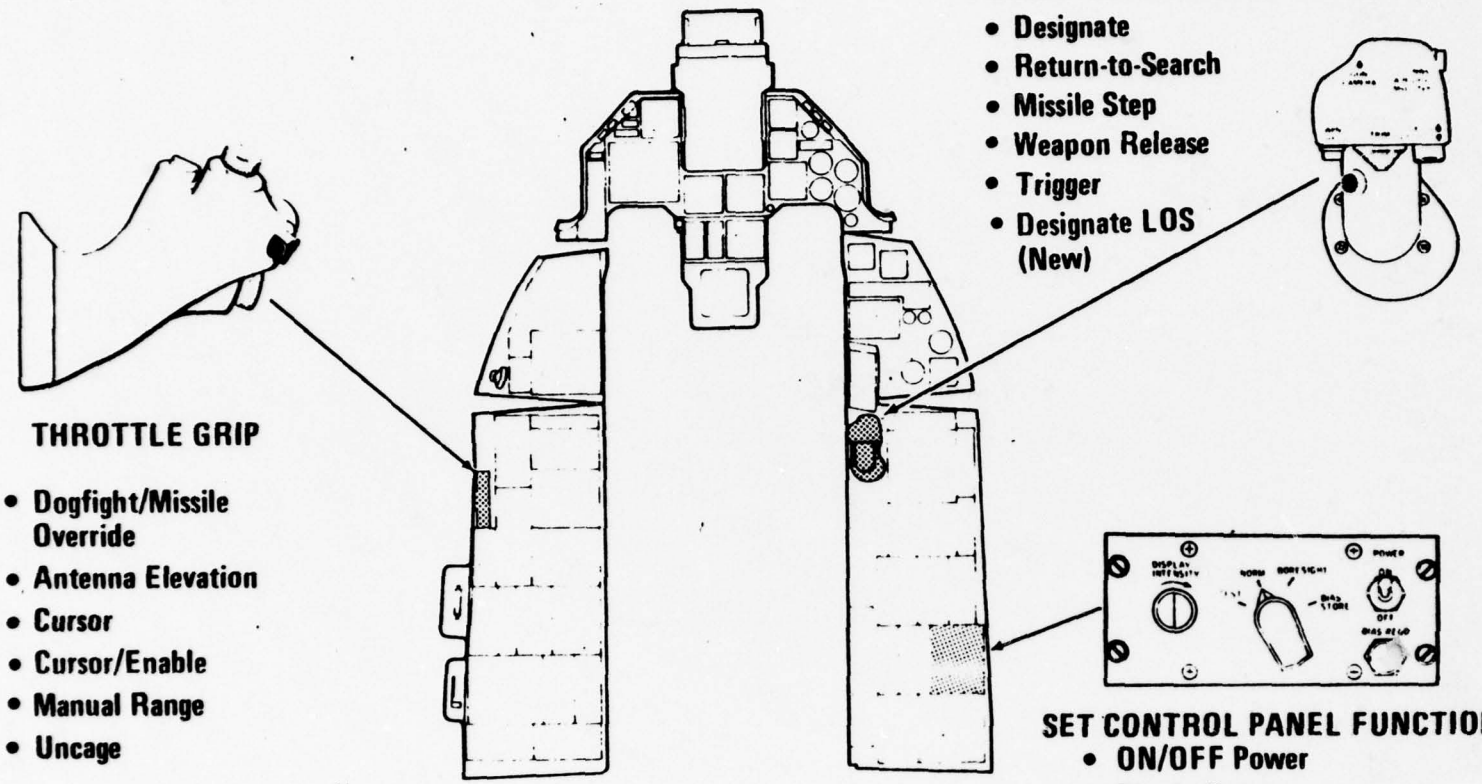
HANDS ON CONTROL



FLIGHT CONTROLLER

- Designate
- Return-to-Search
- Missile Step
- Weapon Release
- Trigger
- Designate LOS (New)

THROTTLE GRIP

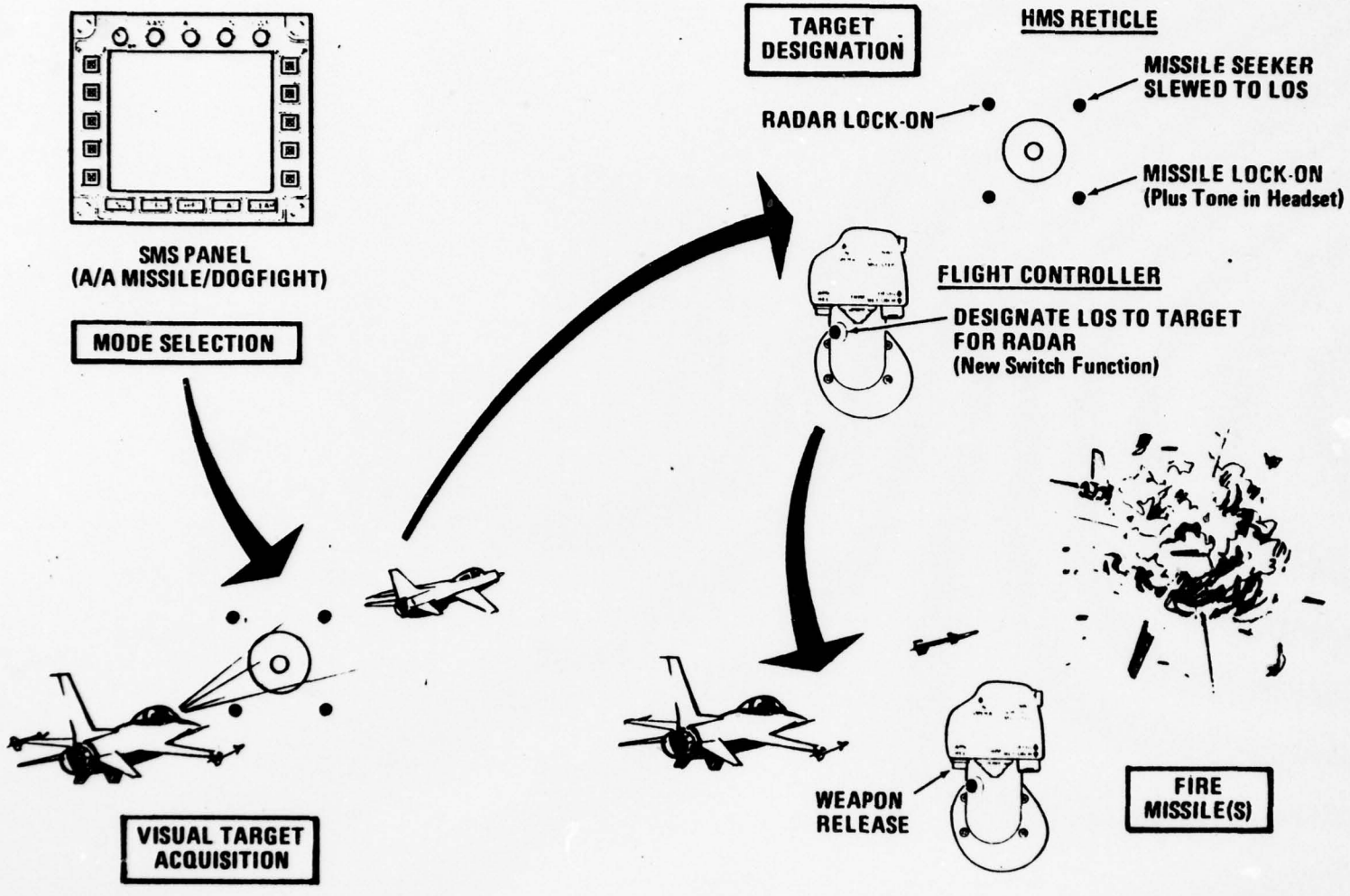
- Dogfight/Missile Override
- Antenna Elevation
- Cursor
- Cursor/Enable
- Manual Range
- Uncage

SET CONTROL PANEL FUNCTIONS

- ON/OFF Power
- Bias Indicator
- Intensity Control
- Mode Select
  - Test
  - Normal
  - Boresight
  - Bias

B5077

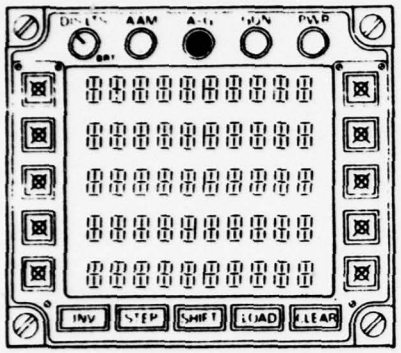
HMS A/A UTILIZATION



OPTIONALLY, THE MISSILE COULD BE SLEWED TO THE HMS LOS DIRECTLY. FURTHER ANALYSIS IS REQUIRED TO DETERMINE IF THIS IS PRACTICAL WITH WING BENDING AND CANOPY DEVIATION ERRORS

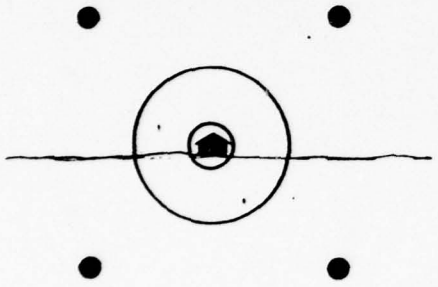
HMS A/G UTILIZATION

MODE SELECTION



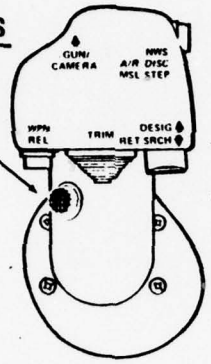
SELECT A/G ON SMS PANEL

SIGHT TARGET



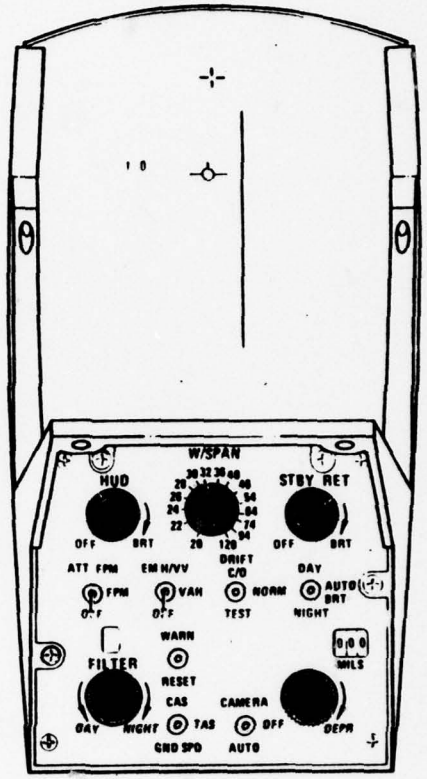
- **HMS ALLOWS HANDS ON LOS DESIGNATION OF HIGH OFF-BORESIGHT-ANGLE TARGETS**

DESIGNATE LOS



- **AVIONICS SYSTEM ACCEPTS HMS LOS TO TARGET OR OFFSET AIMPOINT (New Switch Function)**
- **RADAR CAN SLEW TO LOS**

FOLLOW STEERING



HUD

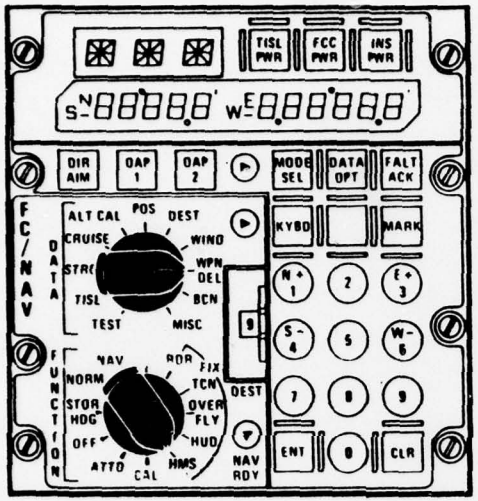
- **PILOT FOLLOWS NORMAL WEAPON DELIVERY STEERING TO RELEASE POINT**

B5079

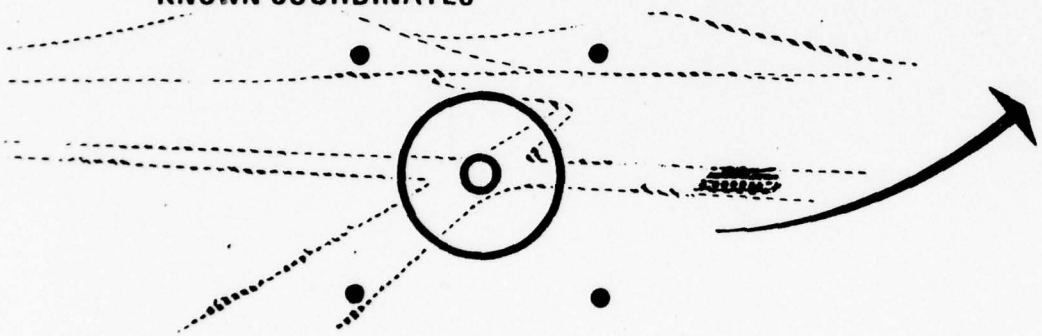
HMS NAV UTILIZATION

– FIX TAKING –

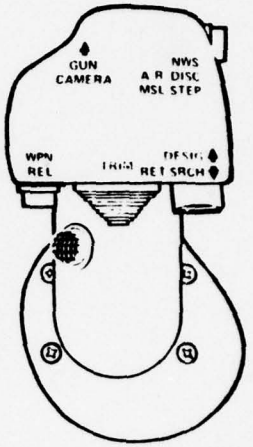
- SELECT FIX/HMS ON FCNP (New Switch Function)



- SIGHT LANDMARK WITH KNOWN COORDINATES



SIDE STICK CONTROLLER



- AIM HMS RETICLE DEPRESS DESIGNATE LOS SWITCH (New Switch Function)

B5080A

HMS CHARACTERISTICS SUMMARY FOR CANDIDATE SUPPLIERS

B5081

CANDIDATE HMS SUPPLIERS

DEVELOPMENT STATUS

● POLHEMUS	✔ F-4J FLIGHT TESTED WITH AN/AWG-14 RADAR
● HONEYWELL	✔ 500 SYSTEMS DELIVERED (F-4B/J) ✔ AGILE MISSILE FLIGHT TESTED ✔ PAVE SPIKE FLIGHT TESTED ✔ A7-E FLIGHT TESTED
● MAGNAVOX	✔ IN ARMY FLIGHT TEST ✔ LATAR POD AND AIM-9 INTEGRATION ACHIEVED
● RAYTHEON	✔ AMRL TESTS PARTICIPATION
● MARCONI-ELLIOTT	✔ US NAVY MISSILE TEST CENTER TEST PROGRAM

B5082

CANDIDATE HMS SUPPLIERS

PERFORMANCE

SYSTEM MFGR	TYPE OF SENSOR	*RMS ACCURACY	POTENTIAL ANGULAR COVERAGE	FREEDOM OF MOVEMENT
POLHEMUS	MAGNETIC	0.4 DEG	AZ $\pm 179^0$ EL $\pm 89^0$	2 FT^3 6 FT^3 DEVELOPMENT
HONEYWELL	IR	0.5 DEG	AZ $\pm 180^0$ EL $\pm 60^0$	LAT $\pm 12''$ VERT $\pm 10''$
MAGNAVOX	IR	0.5 DEG	AZ $\pm 135^0$ EL $+85^0$-75^0	LAT $\pm 6''$ VERT $\pm 2''$ F/B $+10''$, $-2''$
RAYTHEON	IR	1.5 DEG INCREASED ACCURACY SYSTEM UNDER DEVELOPMENT	N/A	LAT $\pm 3''$ VERT $\pm 3''$ F/B $+6''$, $-3''$
MARCONI-ELLIOTT	LED	0.5 DEG	AZ $\pm 180^0$ EL $\pm 70^0$	LAT $\pm 4''$ VERT $\pm 6''$

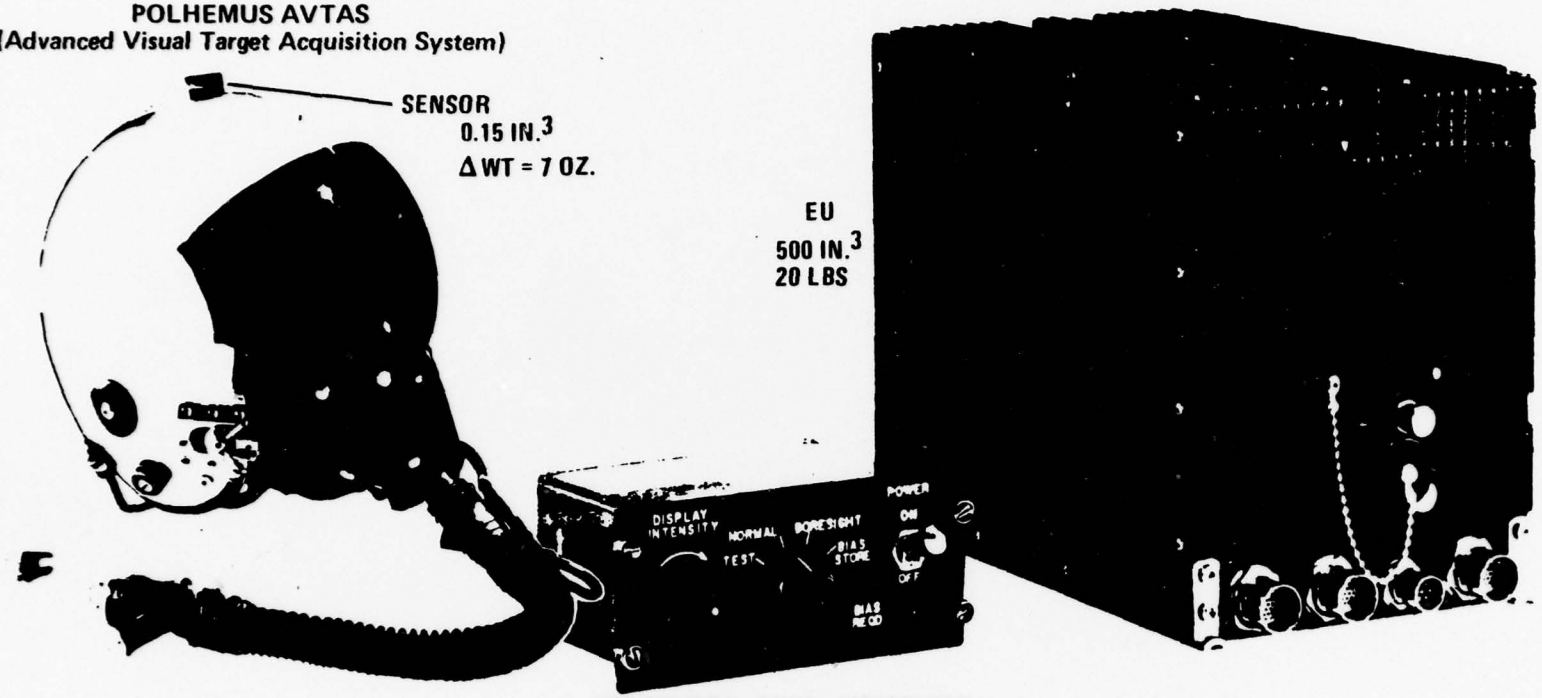
**Excludes External Error Sources Such as Canopy*

B5083A

CANDIDATE HMS SUPPLIERS

PHYSICAL CHARACTERISTICS

POLHEMUS AVTAS
(Advanced Visual Target Acquisition System)



SET CONTROL PANEL FUNCTIONS

RADIATOR
1 IN.3

- **FEATURES**
  - One Radiator Can Be Located Anywhere in the Cockpit
  - Proposed Use of LED Reticle Display
  - Small, Lightweight Magnetic Sensor and Radiator to Determine Head Movement
  - Compatible with CRT Generated-Fiber Optic Display
- **F-16 INSTALLATION CONSIDERATIONS**
  - A Magnetic Mapping Must Be Made for Every Unique Cockpit Configuration

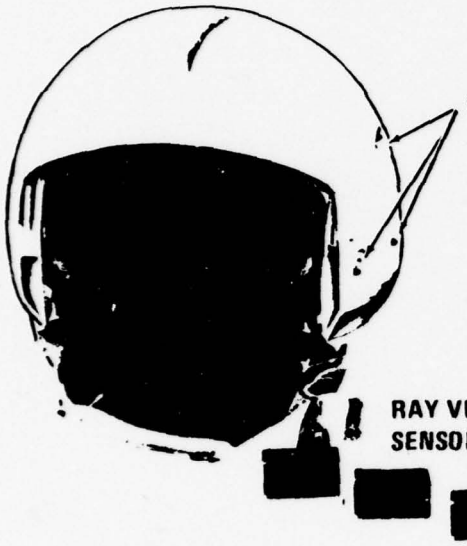
B5084A

CANDIDATE HMS SUPPLIERS

PHYSICAL CHARACTERISTICS

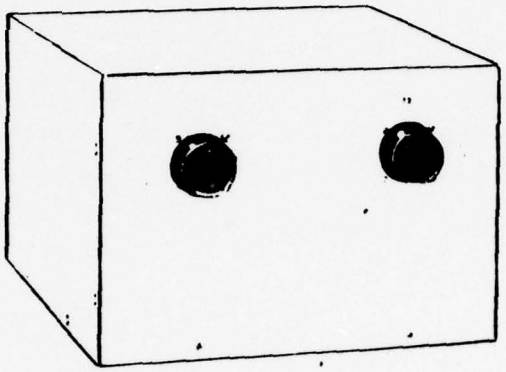
MAGNAVOX HAWC
(Helmet Acquisition Weapon Controller)

SET CONTROL PANEL FUNCTIONS



LED SOURCE
ΔWT = 4 OZ.

RAY VECTOR SENSORS 2 IN^3



VECTOR PROCESSING UNIT (VPU)

9.5 LBS
475 IN.^{3}

FEATURES

- Two, Three or Four Ray Vector Sensors May Be Mounted Anywhere in the Cockpit
- Unrestricted Head Movement Can Be Achieved
- Infrared Detection Sensors to Determine Head Movement
- Uses LED Generated Display

F-16 INSTALLATION CONSIDERATIONS

- Possibility of Fogging of Infrared Detectors/Transmitters

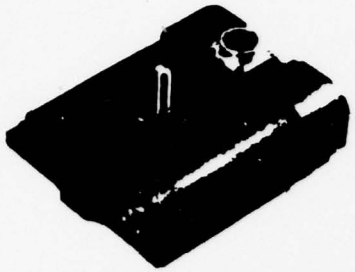
B5085A

CANDIDATE HMS SUPPLIERS

PHYSICAL CHARACTERISTICS

HONEYWELL VTAS
(Visual Target Acquisition System)

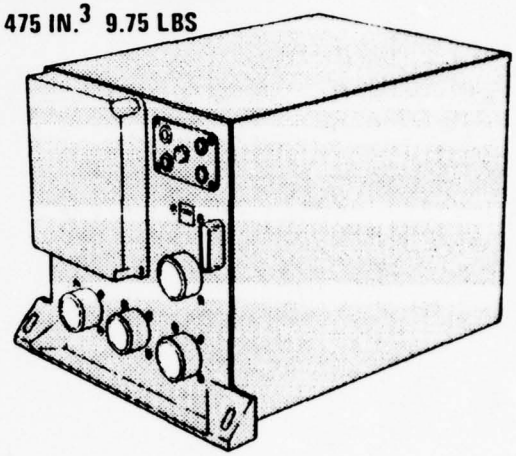
SENSORS
ΔWT = 7 OZ.



SENSOR SURVEYING UNIT (2)
5 IN. x 6 IN.
2.5 LBS

SET CONTROL PANEL FUNCTIONS

COMPUTER ASSEMBLY
475 IN.^{3} 9.75 LBS



FEATURES

- Uses LED Generated Display
- Infrared Detection Sensors to Determine Head Movement

F-16 INSTALLATION CONSIDERATIONS

- Possibility of Fogging of Infrared Detectors/Transmitters
- Sensors Require Special Cantilevered Installation
- SSU Angular Coverage May Be Reduced Due to Mounting Location

B5086A

CANDIDATE HMS SUPPLIERS

✔ *RAYTHEON*

- BASELINE SYSTEM QUOTED TO BE SAME AS TESTED IN AMRL STUDY; HOWEVER, NO LITERATURE WAS SENT TO GD

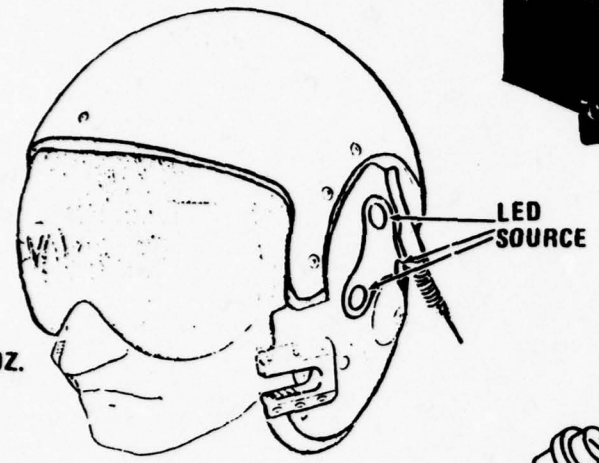
- ADVANCED SYSTEM IS IN WORK – LOW KEY EFFORT
  - USES TWO SENSORS IN LIEU OF FOUR USED ON BASELINE – SENSORS ARE 3/4 IN. DIA BY 1-1/4 IN. DEEP
  - SENSORS HAVE 30 DEG COVERAGE, BUT ONLY ONE SENSOR NEED BE LOCKED TO HELMET SENSORS (8 LEDs on Helmet)
  - VOLUME STIPULATED TO BE $\leq$ 500 IN.^{3} FOR ELECTRONIC UNIT

B5087A

CANDIDATE HMS SUPPLIERS

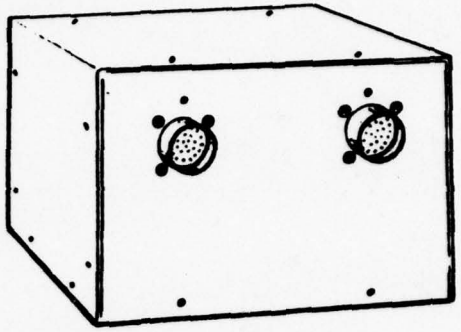
PHYSICAL CHARACTERISTICS

MARCONI-ELLIOTT HMD
(Helmet Mounted Display)



ΔWT = 7 OZ.

SET CONTROL
PANEL FUNCTIONS



SIGHT ELECTRONICS UNIT
1/2 ATR SHORT BOX

V SLIT CAMERAS
2.25 DIA x 2.5 IN. LONG

FEATURES

- LED ARRAY DISPLAY
- LED SOURCE/CCD CAMERA SENSORS TO DETERMINE HEAD POSITION

F-16 INSTALLATION CONSIDERATIONS

- SENSOR PHYSICAL SIZE PRESENTS AN INSTALLATION PROBLEM
- SLIGHTLY REDUCED FOV DUE TO SENSOR CAMERA MOUNTING

B5088A

HMS INTERFACE

B5089

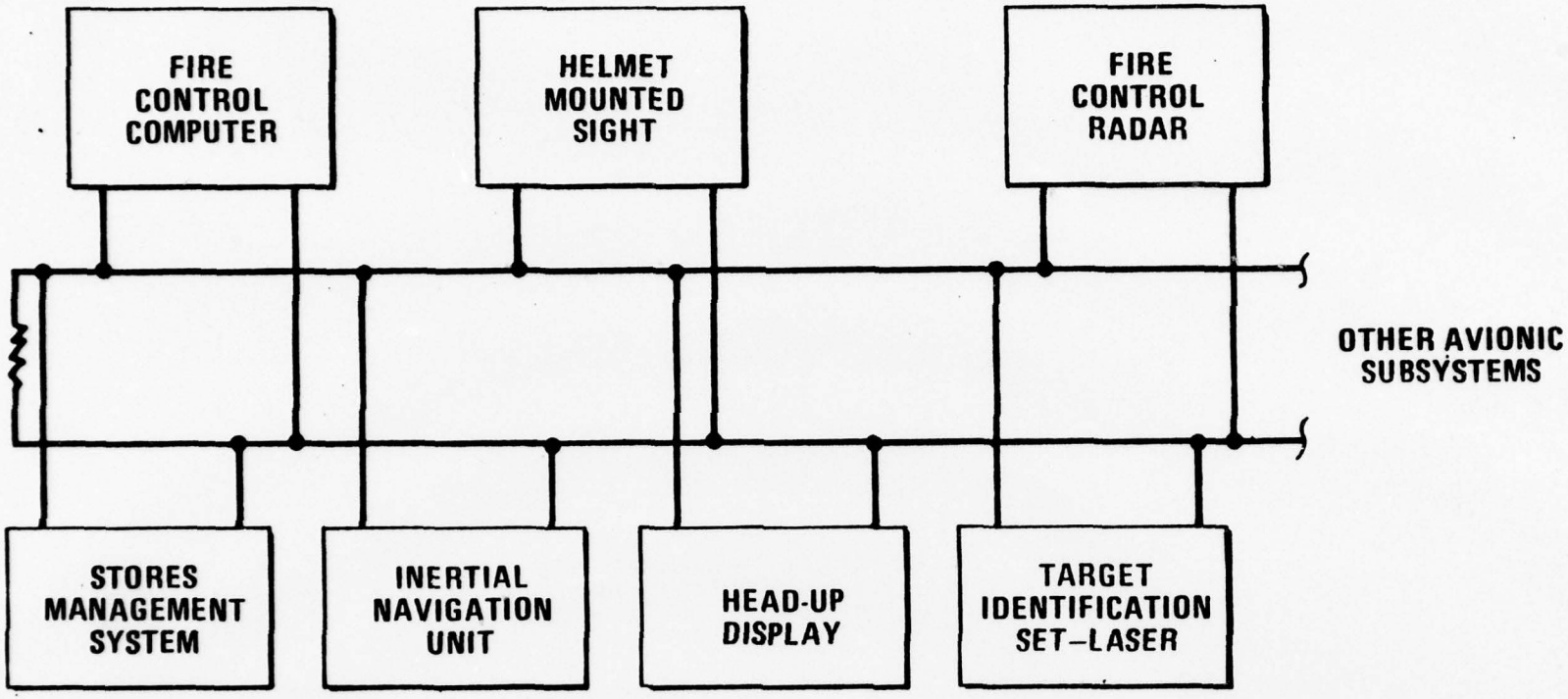
ELECTRICAL INTERFACE

B5090

ELECTRICAL INTERFACE

B5090

INTEGRATING HMS INTO F-16 AVIONIC SYSTEM



FEATURES:

- ✔ HMS TRANSMITS LOS ANGLES AND BIT/SELF TEST INFORMATION WHEN COMMANDED BY BUS CONTROLLER (FCC PRIMARY CONTROLLER – INU IS BACK-UP)
- ✔ HMS RECEIVES MODE COMMANDS FROM SMS, SYMBOLOGY COMMANDS FROM FCC AND BIT COMMANDS FROM FCC VIA MUX

B5091

ELECTRICAL INTERFACE

SIGNAL INTERFACE

- **HMS REQUIRES THE FOLLOWING INPUT PARAMETERS:**
  - ✔ **ANALOG/DISCRETE**
    - *POWER ON-OFF*
    - *RETICLE INTENSITY CONTROL*
    - *MISSILE LOCK-ON*
  - ✔ **MUX DATA**
    - *MODE SELECTION*
    - *RADAR LOCK-ON*
    - *SEEKER HEAD COINCIDENT WITH RETICLE LOS*
    - *BIT COMMAND*
- **OUTPUT PARAMETERS ARE:**
  - ✔ **ANALOG/DISCRETE**
    - *NONE*
  - ✔ **MUX DATA**
    - *AZIMUTH LOS ANGLE*
    - *ELEVATION LOS ANGLE*
    - *SELF TEST/BIT STATUS*
    - *MISSILE LOCK-ON*

POWER REQUIREMENTS

- **AC POWER – 3 ϕ 115/200 VAC, 400 Hz PER MIL-STD-704A, CATEGORY B**
  - *300 VOLT AMPS*
- **DC PWR – 28 VDC PER MIL-STD-704A**
  - *50 WATTS MAXIMUM*

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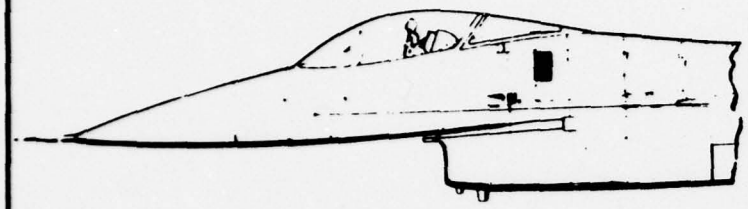
HMS INSTALLATION

B5093

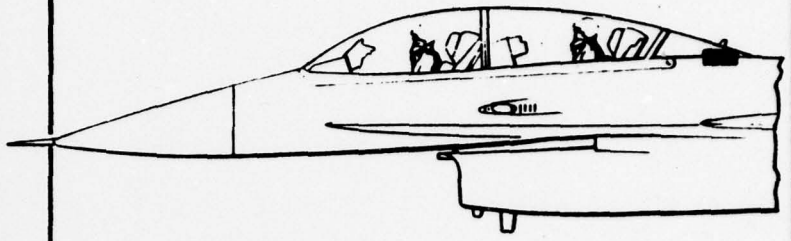
HMS ELECTRONIC UNIT INSTALLATION CONSIDERATIONS

F-16A



- UTILIZES GROWTH SPACE IN AFT AVIONICS EQUIPMENT BAY
  - Exact Location Dependent on Future Equipment Allocation
- ENVIRONMENT – DESCRIBED IN GD DOCUMENT NO. 16PS011
  - Specific Temperature/Vibration Can be Determined When Installation is Firm
  - Reference GD Dwg FW7715025 for Current Proposed Installation

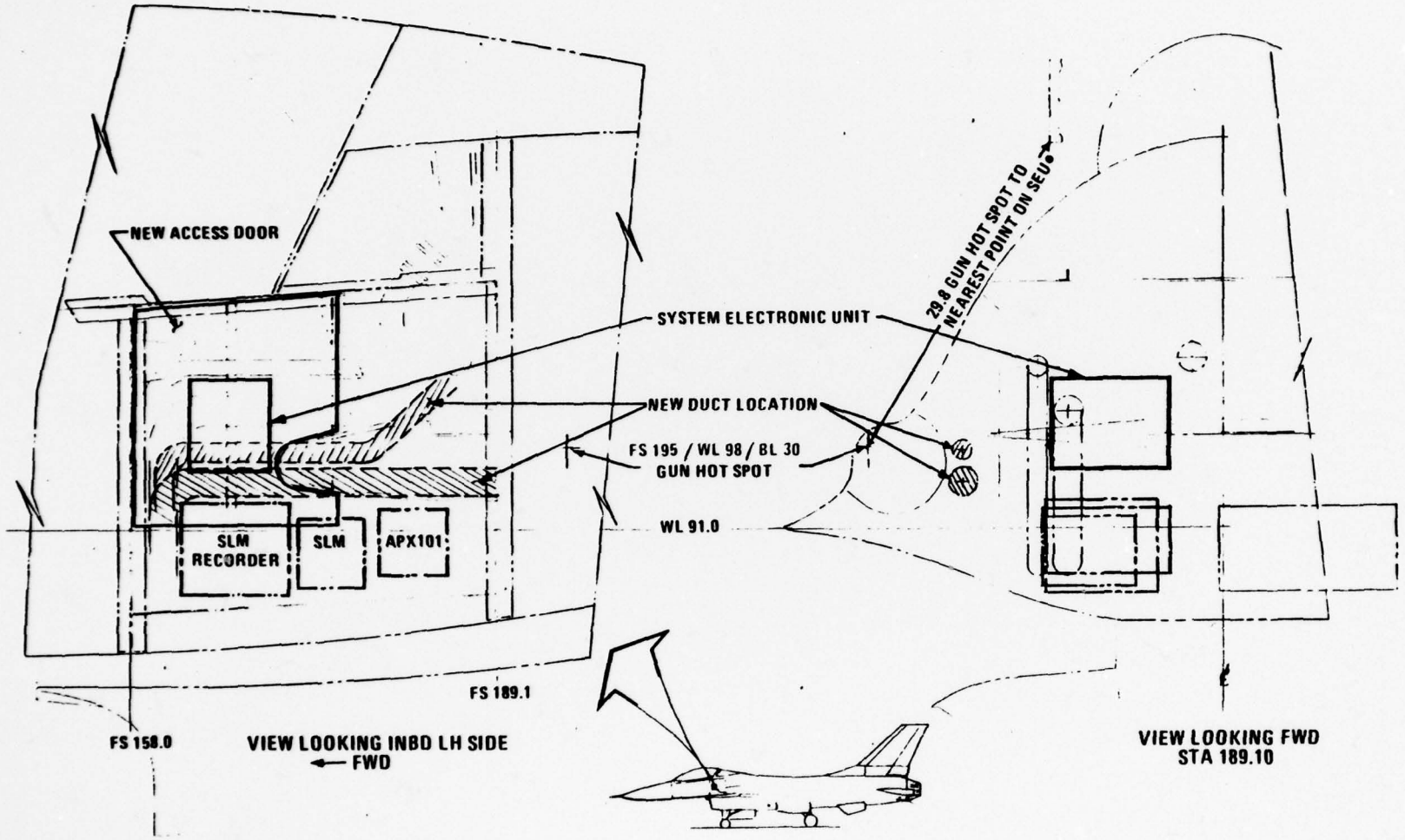
F-16B



- GROWTH VOLUME FOR AVIONICS IS CURRENTLY BEING EVALUATED
- POTENTIAL NEAR TERM SOLUTION FOR INSTALLATION SHOWN ABOVE IN CANOPY FAIRING AREA OF AFT EQUIPMENT BAY
- ENVIRONMENT – DESCRIBED IN GD DOCUMENT NO. 16PS011

B5094

PROPOSED HMS ELECTRONIC UNIT INSTALLATION DRAWING – F-16A

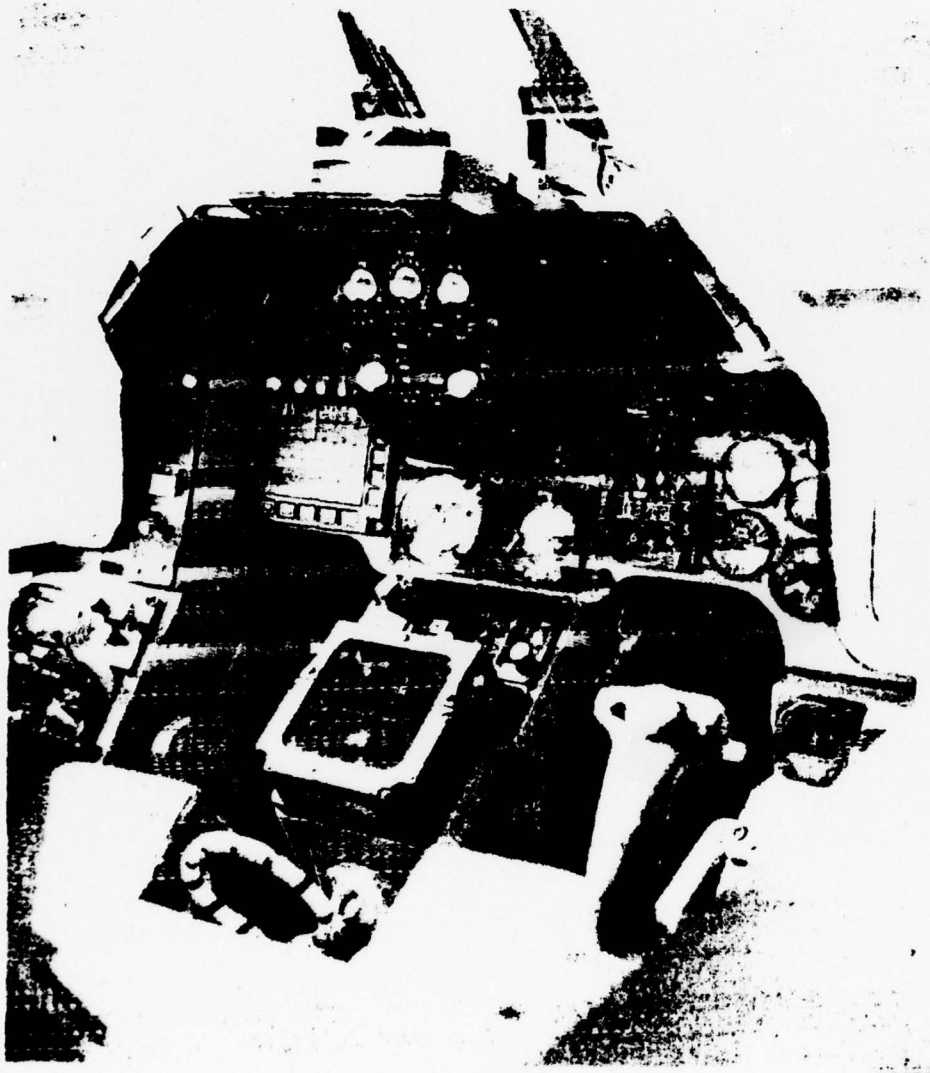


B5095

COCKPIT INSTALLATION CONSIDERATIONS

B5096

F-16 COCKPIT



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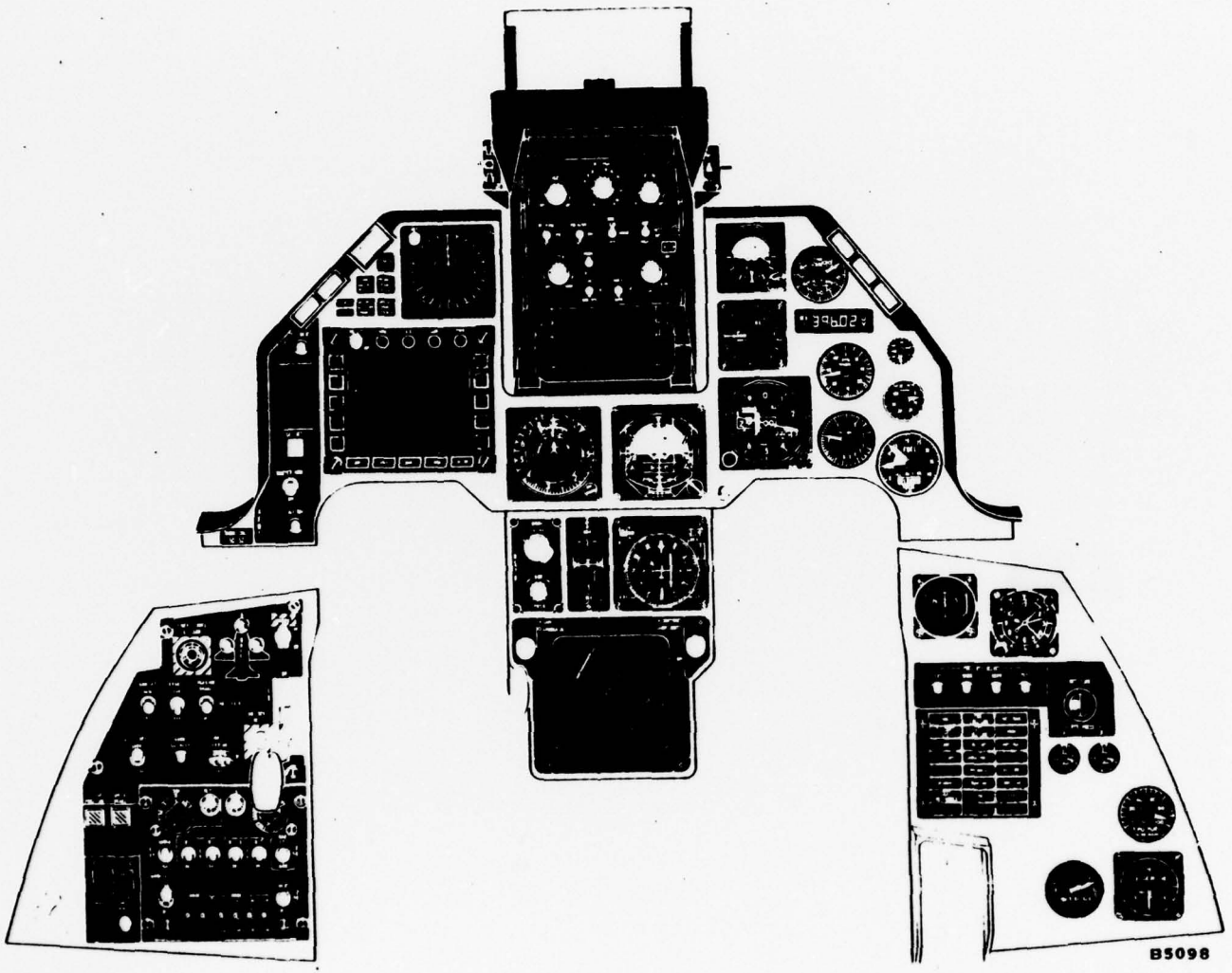
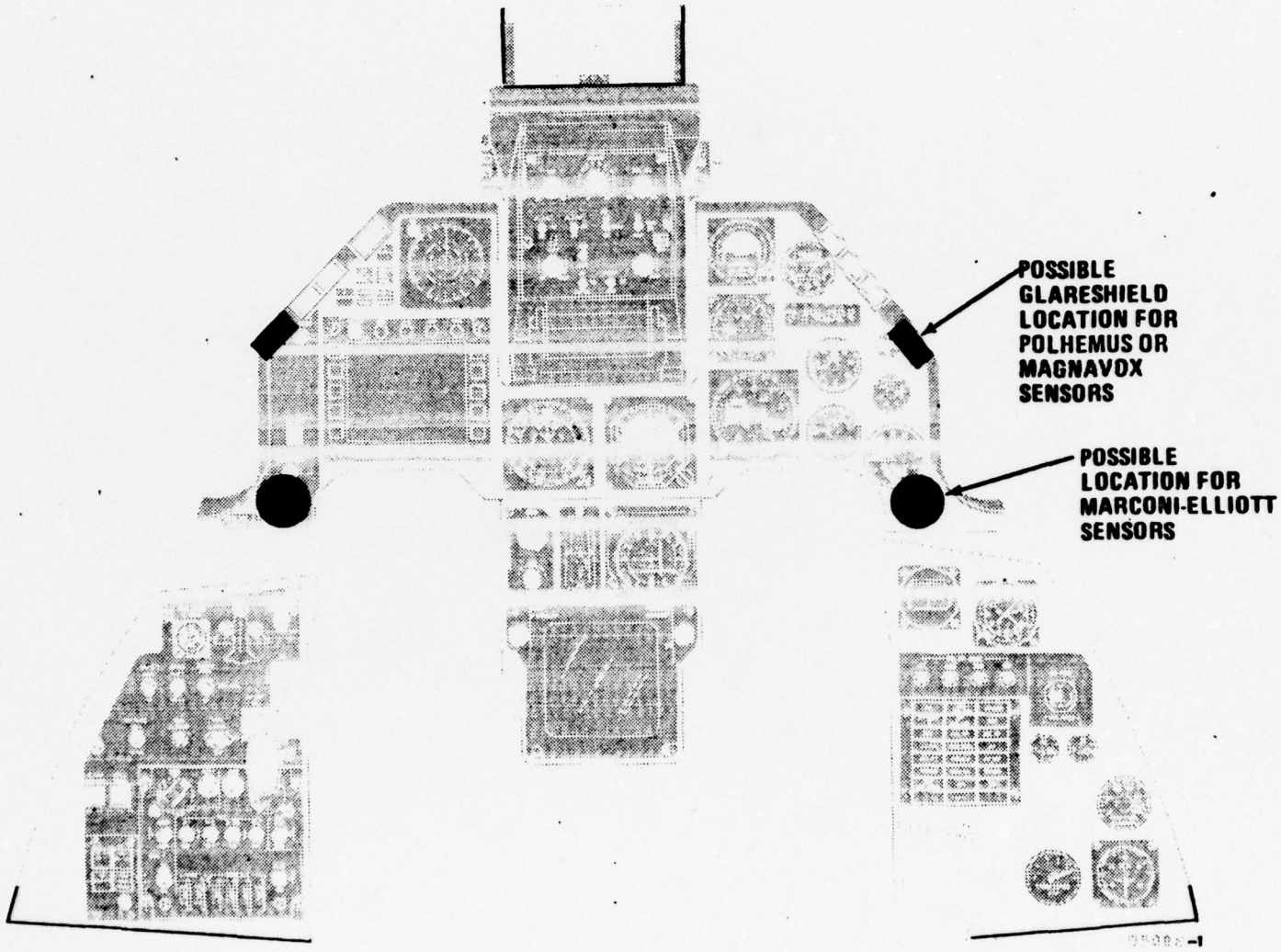
F-16 COCKPIT CONFIGURATION

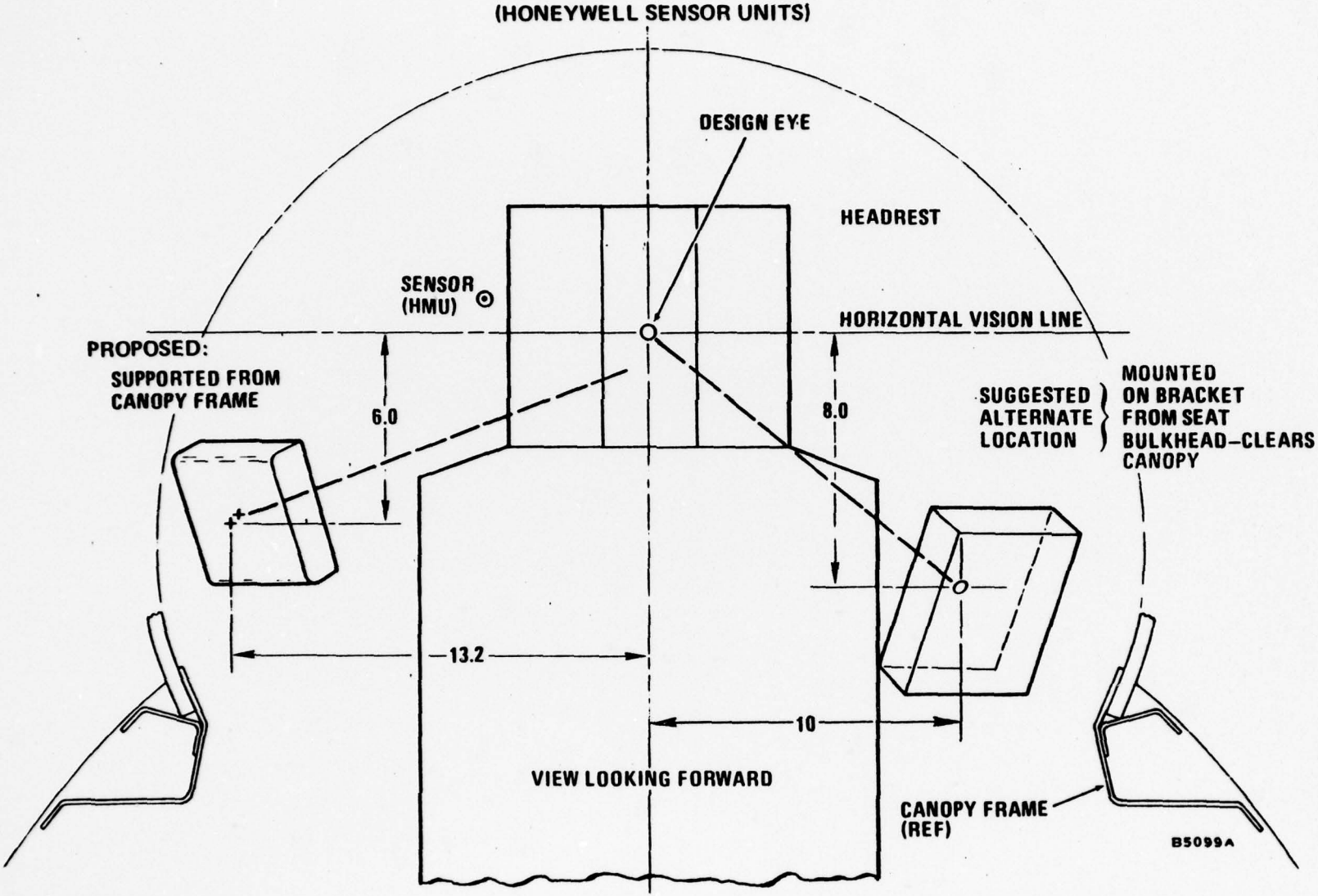


F-16 COCKPIT CONFIGURATION

PROPOSED SENSOR MOUNTING LOCATIONS

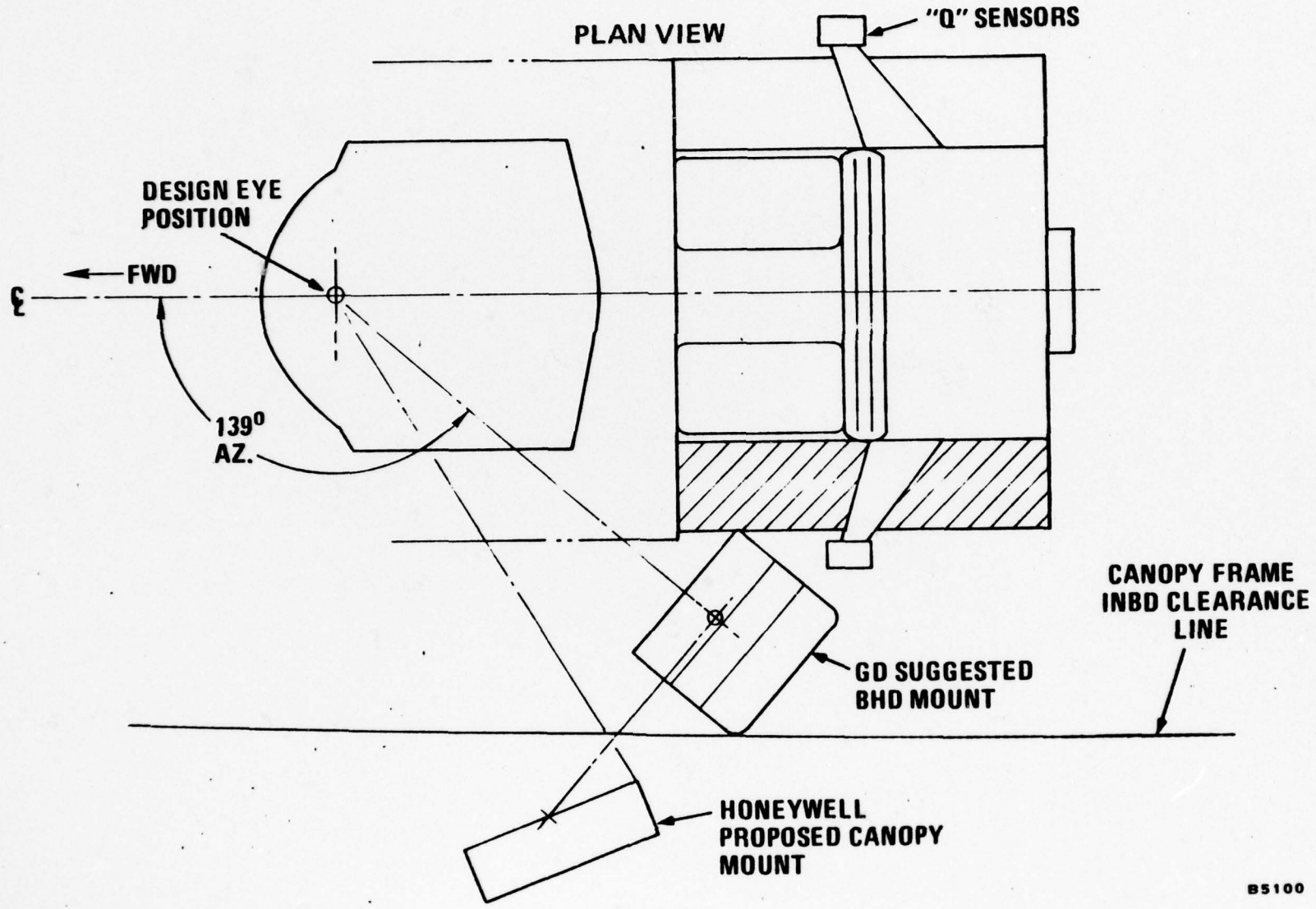


HMS COCKPIT INSTALLATION

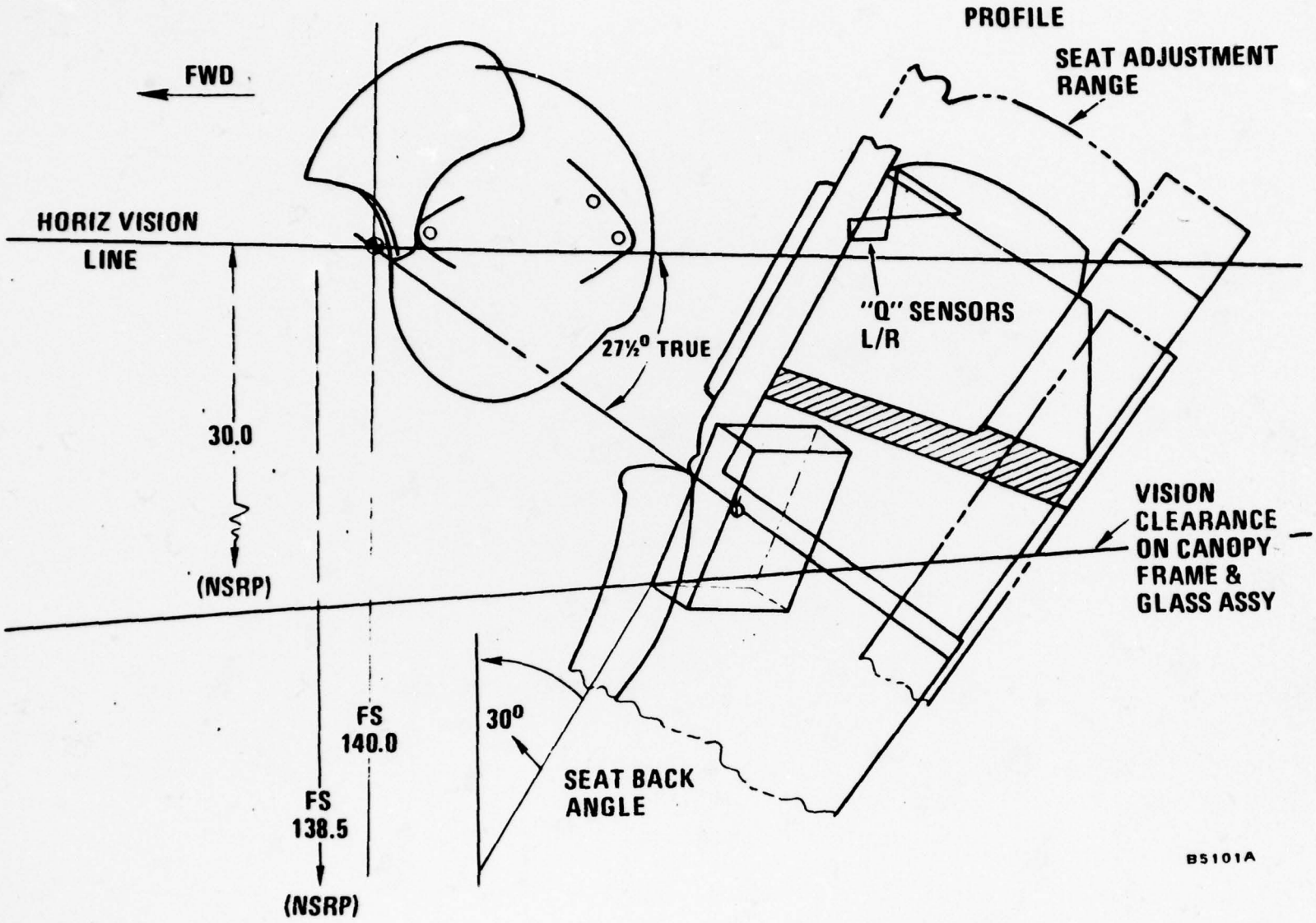


ALTERNATE LOCATION

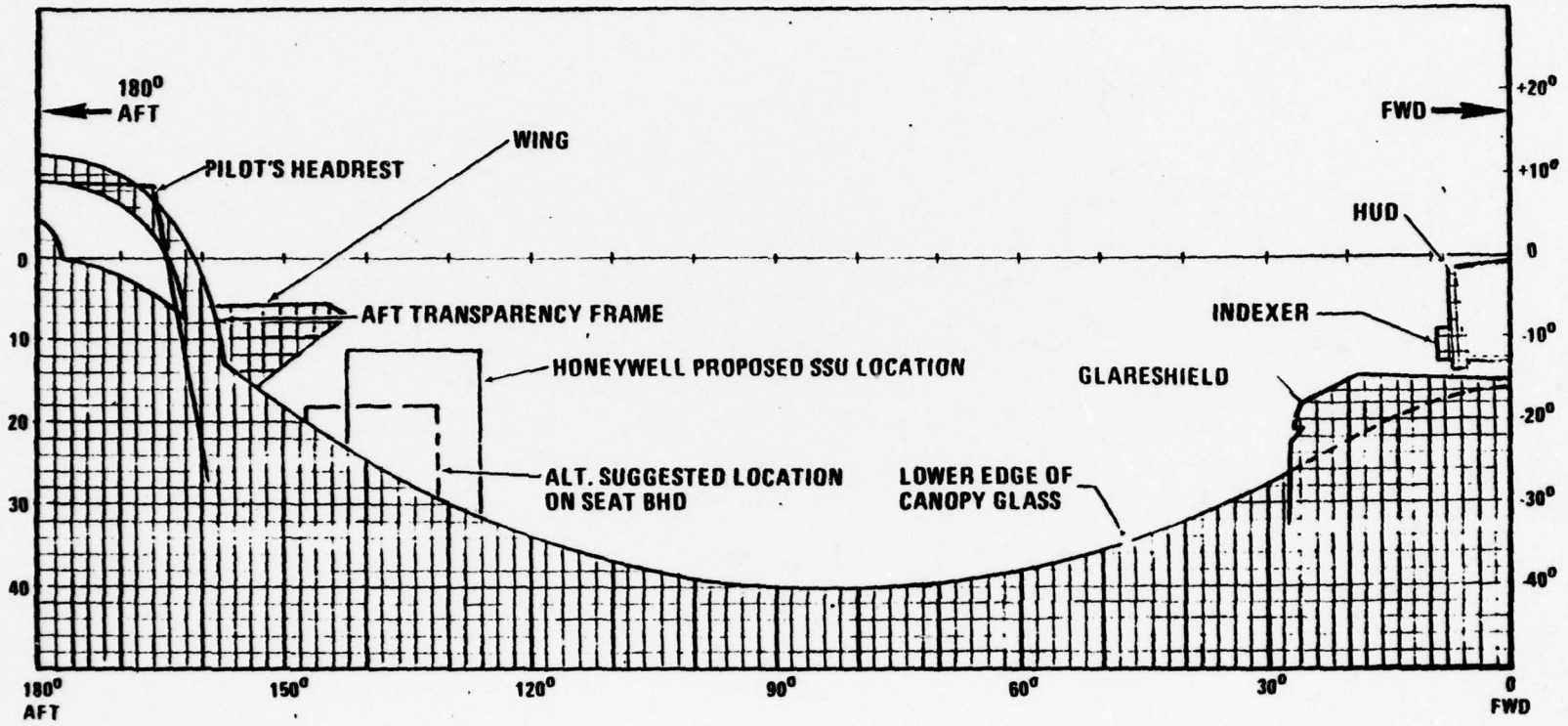
COMPARISON: PROPOSED vs. SUGGESTED LOCATION



PROFILE VIEW – HONEYWELL SUGGESTED SENSOR LOCATION



F-16A PILOT'S EXTERNAL VISION PLOT – HONEYWELL SENSOR VISION BLOCKAGE



HEAD POSITION SENSOR UNITS INSTALLATION SUMMARY

RELATIVE EASE OF INSTL	SIGHT SYSTEM CANDIDATES	PRINCIPAL CONSIDERATIONS (Based on Supplier Preferences)	COMMENTS ON FEASIBILITY
1	POLHEMUS	• LOCATION ON INSIDE SURFACE OF CANOPY, ABOVE/BEHIND PILOT'S HEADREST OR ON AFT EDGE OF GLARE SHIELD • NO VISUAL BLOCKAGE PENALTY	• Only Easily Installed Candidate • Further Study of Canopy "Breathing" Required
2	MAGNAVOX	• FOUR SENSORS PREFERRED FOR BEST CONFIGURATION ✓ Two Integrated into Aft Edge of Glareshield (Redesign Task) ✓ Two Supported from Brackets Cantilevered Off of Seat Bulkhead	• Two Sensors Accommodated on on Instrument Panel Glareshield • Further Study Required for Additional Sensor Locations Possibly Outboard of Seat and Inboard of Canopy Frame
3	MARCONI-ELLIOTT	• V-SLIT CAMERAS EASILY MOUNTED IN SUPPORTS FROM SEAT BULKHEAD • SLIGHT VISUAL BLOCKAGE AT 138-140 DEG AZ • ALTERNATE LOCATION AT SILL LINE-INTEGRATED INTO LOWER CORNERS OF INSTRUMENT PANEL (Extensive Changes)	• Physical Size is an Installation Problem (Protuberance into Cockpit)
4	HONEYWELL	• CANOPY FRAME MOUNTING REQUIRED FOR ADEQUATE VIEWING OF LEDs ON HELMET ✓ Subject to Canopy "Breathing" ✓ Significant Blockage to Down/Aft Vision (At Approx. 135 Deg AZ)	• SSU Size Precludes Usable Location Without Significant Vision Blockage – No "Good" Location in a Cockpit Optimized for External Vision

•PRELIMINARY ASSESSMENT BASED ON COCKPIT INSTALLATION CONSIDERATIONS:

•POLHEMUS MAGNETIC SENSOR APPEARS MOST ATTRACTIVE

•HONEYWELL SYSTEM IS MOST DIFFICULT TO ACCOMMODATE

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SUMMARY

- **ALL CANDIDATE SUPPLIER QUOTED ACCURACIES COMPATIBLE WITH SLEWING FIRE CONTROL RADAR TO HMS LOS (CURRENT APPLICATION)**
  - *RADAR CURRENTLY SLEWS AIM-9L TO RADAR LOS*
  - *FIRE CONTROL COMPUTER CURSOR CONTROL SLEWS RADAR ANTENNA FOR A/G TARGETS – COULD USE SIMILAR TECHNIQUE FOR SLEWING RADAR TO A/A TARGETS*
  - *RAYTHEON HMS ACCURACY IS MARGINAL*

- **HMS INSTALLATION IMPACT INCLUDES**
  - *MUX BUS CONTROL CHANGE – FCC AND INU*
  - *A MINIMUM OF TWO ADDITIONAL SWITCH FUNCTIONS REQUIRED – PLUS SWITCH FUNCTIONS DEPICTED ON HMS CONTROL PANEL*
  - *SOFTWARE CHANGE FOR STORES MANAGEMENT SET AND FIRE CONTROL COMPUTER*

- **A/P POWER, INSTALLATION VOLUME AND COOLING CAPACITY ARE AVAILABLE**

AREAS OF CONCERN

- **SENSOR INSTALLATION**
  - *LARGE SIZE OF HONEYWELL OPTICAL SYSTEM IMPACTS PILOT'S VISION*
  - *CANOPY SIL MOVES WITH A/P LOAD FACTOR AND COCKPIT PRESSURE SCHEDULE*
  - *BULKHEAD INSTALLATION REQUIRES CANTILEVER INSTALLATION*
  - *MAGNETIC SENSOR REQUIRES COCKPIT MAPPING FOR BIAS CORRECTION – TWO SEAT F-16 MAY REQUIRE UNIQUE MAP*
  - *CANOPY LOS ANGULAR DEVIATIONS/EFFECTS (NEED FURTHER ASSESSMENT)*

- **PILOT ACCEPTANCE**
  - *ADDITIONAL HELMET WEIGHT IN HIGH "G" ENVIRONMENT*

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RECOMMENDATIONS

- **F-16 INTERFACE SHOULD IMPACT AF HMS SELECTION/SPECIFICATIONS**
  - ✔ Cockpit Installation Constraints
  - ✔ MIL-STD-1553 MUX-Interface
  - ✔ Integrated Controls
- **FURTHER STUDIES WILL BE REQUIRED TO ASSESS F-16 HMS MODES/UTILIZATION WITH NEW WEAPONS**
  - ✔ High Angle Off Boresight Compatible A/A Missile(s) – Contingent Upon Current AF Studies Results (AIM VAL, etc)
  - ✔ Slewable E O A/G Weapons
  - ✔ Pod Installed Sensors
- **PROPOSE ADDITIONAL STUDY TO GENERATE F-16 HMS INTERFACE SPECIFICATION – PRELIMINARY S.O.W. AVAILABLE**

BS1C5